

The CHICAGO NATURALIST



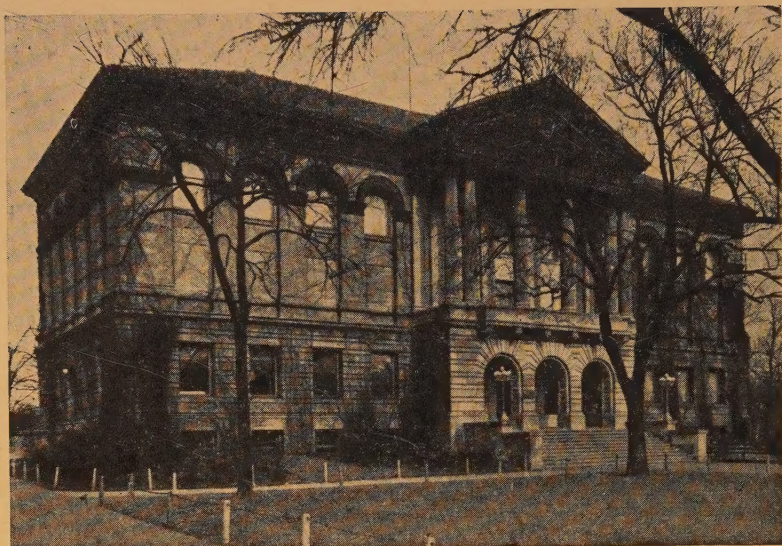
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Autumn Coloration

CHARLES A. SHULL*

It is only midsummer as this paper is being written, but already the lower leaves of the sumacs are prophesying autumn with the crimson tips and edges of their lower leaves and leaflets; and certain branches of the dogwoods are putting on a dull red color. By early September Autumn will be abroad with her paints, and the ends of some branches of the scarlet maple will show where she has thrust her brush. A single branch, perhaps, will be blushing in scarlet surprise at her bold approach. Soon the whole landscape will take on myriad hues, and the forests will present themselves as lovely mosaics, pleasing to the eye, and challenging the wonder and admiration of all who appreciate artistic natural paintings.

The northern hemisphere is especially blest with colors. Wherever there are deciduous forests, autumn is likely to develop brilliant colors; but much depends on the circumstances of climate and location. In more southern latitudes, the highlands are conspicuous for their beauty. A trip through the Ozarks of Missouri and Arkansas in late September, or through the mountains of the Carolinas, or through the hills of Brown County, Indiana, will enable the traveler to enjoy these mosaics in all their glory while there is a differential of development between those trees that color early, and those that wait until later in the season before becoming brilliant. Not only does altitude affect the brilliancy of coloration, but latitude, also. The northern forests, lying south of the Canadian Evergreen Belt, become more brilliant, on the whole, than forests of similar composition as to species and of similar altitude, but at more southern latitudes. The reasons for brighter colors at high altitudes, and northern latitudes, are probably largely climatic. The higher altitudes have a cooler climate than the plains; a greater range of temperature between day and night; and the atmosphere of the highlands and northern latitudes is clearer, with more sunlight ultraviolet radiation reaching the surfaces of the leaves. Cool, clear weather and ultraviolet radiation enhance the development of color by favoring the chemical changes involved in autumn coloration. The southern hemisphere has few areas that develop beautiful autumn colors—or should we call them spring colors, since their autumn occurs while we are having spring?

The development of color may be abruptly terminated by a severe freeze. In the autumn of 1926, the forests of Minnesota were royal in crimson robes, wherever, and as far as, the eye could see. But in 1935 an early freeze congealed the same landscapes in dull shades of green and gradual brown.

*Professor Emeritus of Plant Physiology, University of Chicago. Present address 42 Oakwood Road, Asheville, North Carolina.

The mountain slopes in North Carolina in late September and early October are gorgeous mosaics, of unbelievable brightness and beauty. The oaks remain green at first, while the scarlet maples, sourwoods, dogwoods and sumacs turn scarlet and crimson. The yellow poplars turn brilliant yellow, the hickories are yellow to orange, and look like great golden statues among the other trees. The ash trees, and occasional persimmons, are often a dull purplish color. As the slopes are steep, each tree can be seen as an individual, rank upon rank, up the mountain sides; and the irregular distribution of the species results in sublime mosaics that rival the most colorful work of the creative artist. As the season progresses the green oaks change to flaming crimson bouquets, and so the character of the mosaics change as autumn progresses, until the whole landscape is a magnificent riot of color.

To the uninitiated these color changes may seem like a miracle wrought in the great laboratories of nature. The scientist, however, does not think in terms of miracles. Every manifestation of color has its cause and effect relationship; and it makes the glory not one whit less to understand something of the chemistry of color development in plants.

The beauty of the earth is tied up with the existence of plant pigments. The green color of vegetation, so restful to the eye, is due to the presence of chlorophylls, green pigments which *are* green because they absorb the complementary red color and reflect the green component of daylight. In early spring the vegetation is always yellow-green in color. Before the chlorophyll develops by chemical and photochemical reactions, the tissues are pale yellow. This indicates at once that other pigments are present besides the chlorophylls. Four kinds of pigments are often mentioned as occurring in plant cells. Two of them are yellow—the carotenes and xanthophylls; and two are green—chlorophyll *a* and chlorophyll *b*. It is not necessary here to go into the chemical differences between the two yellow and the two green pigments. The yellowish green colors of early spring persist with diminishing yellow until chlorophyll development almost completely obscures the yellow pigments. During the period of vegetation these green and yellow colors exist side by side in the bodies known as chloroplasts. These are protoplasmic bodies which accumulate and probably hold the pigments, particularly the chlorophylls, in chemical combination with the protoplasm.

When autumn comes, the chlorophylls, being nitrogenous compounds, undergo a chemical decomposition. The nitrogen slowly passes back into the plant from the leaves, and the leaves slowly lose all of their green color. During this change the yellow colors begin to show; the carotenes and xanthophylls now become autumn colors, yellow and gold. These colors are in part due also to the presence of sap-soluble yellows which will be mentioned presently.

As has been indicated, the xanthophylls, carotenes, and chlorophylls are not in liquid solution in the leaves, but are associated with morphological structures, the plastids. But there are other pigments in the superficial cells of plants *not* associated with protoplasmic bodies, but dissolved in the cell sap, in the vacuoles especially of epidermal cells. These sap-soluble colors are also of two types: the yellow anthoxanthones and the red, mauve, purple and blue colors, known collectively as anthocyanins.

As has been stated, there is a tendency for these sap-soluble pigments to develop mainly in the epidermal cells. In the garden beet, however, the red color is usually found all through the beet root. But in flowers and leaves the beauty is often "only skin deep."

The chemistry of the anthoxanthones and anthocyanins is very complicated, but the colors may be related in origin. The yellow sap pigments are usually present before the anthocyanins develop. Shortly before the dune *Tradescantias* bloom, their flowers are white inside the closed calyces, but with anthoxanthones in the cell sap. These white tissues turn blue or pink just as the flowers are ready to burst through the buds. It has been suggested that the yellow soluble colors may be changed into blue or red by oxidation-reduction reactions. The structure of the molecules of the two groups of pigments is in agreement with such an hypothesis. Ultraviolet radiation may be related to these oxidation-reduction reactions, for anthoxanthones are more abundant in alpine plants than in those of the plains; and correspondingly, the anthocyanins are more brilliant in alpine plants. That would be expected if the anthoxanthones give rise to the anthocyanins.

The exact conditions for anthocyanin development are not well known. Such factors as the presence of sugar, tannin, cool nights, bright clear days, etc. have been mentioned as more or less contributory. At any rate, autumn produces within the plant the conditions required for production of anthocyanin colors. As the deeper seated chlorophyll bodies disintegrate, the skin-pigments become visible as the superficial colors of the leaves. So it is, then, that dogwoods, sassafras, sumacs, sourwoods, scarlet maples and the oaks become various shades of red, because they develop anthocyanins in the epidermal cells of the leaves. Variegated leaves have localized development of pigments. Hickories and poplars turn yellow because they do not develop pigments in their epidermal regions.

The anthoxanthones and anthocyanins are modifiable in shade of color by the degree of acidity or alkalinity within the cells. When the cells are acid in reaction, the anthocyanins tend to red shades; in neutral condition they are purple; in alkaline media they are blue, or even green. The purple oxalis blossom dipped into a one per cent solution of ammonia or other alkali (sodium or potassium hydroxide) becomes as green as grass. This never happens naturally, of course. Lilac blossoms

also become green in alkaline solutions. White blossoms, such as the white jasmine, turn yellow in alkaline solutions, owing to the OH ions being an intensifier of the anthoxanthone pigments. Technically the hydroxyl ion is called an *auxochrome*, which means that its presence deepens the yellow color.

From this discussion it should be plain that the exact shades of yellow, red, purple, blue, and orange soluble pigments found in the epidermal tissues of flowers and fruits are related to the active acidity of the cells. When the cells die, they usually become more acid, and blue flowers often become red in death. Have you ever watched the intense blue color of the chicory blossom change to red as the flower withers, or the heavenly blue morning-glory? Sometimes blue morning-glories develop red streaks along the leaf veins before the flowers wither. Age and death release acids, and membranes lose their semipermeability at death or before; so the blue pigment—blue only because it is in an alkaline medium—turns red when deterioration with age and oncoming death permits acidification to occur.

The overlapping of colors is also important. The chromoplasts containing the yellow carotenes or xanthophylls are deep-seated, and when overlaid by anthocyanin-containing epidermis, a yellow-red or scarlet appears if the anthocyanin is red. If it is bluish in color, crimson results, so far as the anthocyanins are responsible. Anthocyanin in reddish hues over chlorophyll produces a rich brown color, as in *Coleus* leaves. And the purplish colors of the ash in autumn may involve overlapping of bluish anthocyanins and chlorophyll.

By changes in the intensity of all factors, the marvelous variety of shades is produced. No two autumns are ever exactly alike. The same trees do not always develop the same degrees of color. They are creatures of their environment, subject to the laws of nature—the laws of the Creator of all things. The challenge of the supreme beauty of ageing and dying things is of high ethical value to all of us, who, likewise, are creatures subject to ageing, decay, and death. One might well say of autumn what Housman once poignantly said of spring in *The Shropshire Lad*: There are so few autumns in a life-time that we should go about the woodlands every year to see the trees silently putting on their robes of glory . . . before they stand in utter nakedness before the blasts of winter.

Some Pets of the Trailside Museum

CONSTANCE NICE

Sketches by Violet Fogle



Skunks had been primarily a fur on a coat or a scent on the breeze to me, until I became acquainted with two fat youngsters, Benny and Tarbaby, stars of the Trailside Museum of the Cook County Forest Preserves. Both wore chic black and white suits, neat and shiny, like the fur of every healthy animal. Both submitted politely to being caught from under a table or in their cage, and to being carried about and petted. Both had a faint but pungent odor, a sort of reminiscence of the outdoors, rather pleasant. However, the curator, Miss Virginia

Moe, said that John, the white rabbit, and other animals rather avoided the society of the skunks—just like the B. O. ads.

Benny was always less tame than his sister, and would amuse visitors by stamping his feet and erecting his tail. Both skunks had been operated on to remove their scent glands, before they came to the museum. One morning, however, when Benny was being handled by one of the unofficial assistant curators—the youngsters who haunt the museum—it became unmistakably clear that his operation had not been a success!

When I brought some live grasshoppers to the Trailside Museum, they were received enthusiastically by the fish, the frogs, the salamanders, the fox squirrels, the striped ground squirrels, and the house mice, but by none more eagerly than by the little skunks. After Tarbaby had snapped at an insect and caught my finger nails too, I let her put her head in the jam jar to help herself. It was very funny to see her lunge at a grasshopper in such close quarters. In



the dark cage, however, the skunks seemed to be unable to locate insects until their noses were almost upon them. As a pet skunk is reported to have caught quantities of locusts in sunny meadows, I suppose that Tarbaby and Benny were hampered both by lack of light and lack of practice. Grasshopper hunting, like baseball, must be learned.

Miss Moe has a real gift with baby animals and has succeeded in raising many young squirrels, red,





gray and fox. She finds fox squirrels the most placid of the three species and the least liable to bite when startled; indeed, they make affectionate pets. Although in the wild, squirrels have not been found to be social, in

the Museum, individuals that have been raised together, live peaceably in groups of three or four in one cage. But when one fell sick and was isolated for a week, upon its recovery its former friends, instead of welcoming it, fell upon it!

One gray squirrel lived at Trailside for as long as eight years. Another, named Pat-a-cake, was a great pet and had many amusing tricks. She would do somersaults, play dead, and open her mouth to let visitors inspect her sharp molars. She liked to jump from shoulder to shoulder of admiring visitors. And when Miss Moe spread sheets of brown paper on the floor, she would frolic back and forth across them, apparently enjoying the crackling noise, which to us was reminiscent of dead leaves in the forest.



Nothing is more charming, cunning, and friendly than a young coon. I remember a little wild coon, just caught the night before by our neighbors, that climbed over us and explored our hair and ears. Mrs. Martin, wife of the superintendent of the Ohio State Game Farm, has raised hundreds of little coons on the bottle; she always selects some of her nurselings as pets and they remain as tame as dogs. But eventually, every one of them, in a fit of nervousness or temper, has bitten her.

My friend Lyman Carpenter, talented animal artist, has never been bitten, although he kept three pairs of coons for two years. He used to fit them out with collar and leash and take them walking in the park.

Lyman and I visited Tarzan and Jane, the raccoons of the Chicago Trailside Museum. Before they were fed they had no interest in visitors. Afterwards Tarzan came over and put his paws first on my lap and then in my pocket. He seemed to like the feel of my heavy tweed suit. He enjoyed being "wooled around," even on his home shelf, and being picked up, but Jane growled at us when we reached toward her on her shelf. Lyman had found that his pet females were always more timid



than the males, and, besides, Jane has been handled very little.

She is smaller than Tarzan, her fur is finer, and she looks and acts like a perfect lady. Nobody is going to take liberties with her! When Tarzan grabbed her ear, she growled at him until he released her. Although she did not like to have a hand put on her back even when she was on the ground, she would cautiously place a paw on one's lap, and later she climbed up Lyman's back and sat on his head, from which perch she conducted a not very serious quarrel, consisting mostly of threats, with Tarzan.

If a wild animal is not afraid or excited, he can often be handled if you do it gently and firmly. Although Tarzan was so polite to us, later he bit a man who was holding him in his lap during a ride in a truck.

Trailside Museums are made to order for us who are not satisfied with merely looking at animals through bars, but unfortunately cannot keep them ourselves. They offer the best opportunity for becoming personally acquainted with our native animals.

An Appraisal of Natural History

M. MALDONADO-KOERDELL*

Has some of the charm of Natural History, and some of the values to be derived from a broad, as opposed to a narrow, approach to the subject been lost by the modern tendency to specialization in the field of the biological sciences? For many years the words Natural History were commonly used to designate that important department of knowledge dealing with a correlated study of the three "kingdoms" of nature: the mineral kingdom, the plant kingdom, and the animal kingdom. Students of Natural History or "naturalists," as they delighted in calling themselves, considered all the productions of the earth as comprised in one mass. This mass was formed by every object upon its surface and within its crust, man included, and naturalists investigated every evidence of the order existing in things, to enchain in a brilliant synthesis their conception of the unity of nature.

Obviously, therefore, the ideals and discoveries of the earlier naturalists should not be overlooked in these times of complicated paraphernalia in laboratories, and still more complicated (and sometimes extravagant)

*Professor of Comparative Anatomy in the National Polytechnic Institute and of Comparative Morphology in the National School of Anthropology, Mexico City; Latin American Guggenheim Fellow, 1944-46, University of Kansas Museum of Natural History, Lawrence, Kansas.

conclusions drawn from experiments which involve the alteration of natural conditions. This probably explains why the charm that bound Natural History to its whole range of minerals, plants and animals has to some extent been lost in the effort to know more and more of less and less. Old naturalists, like the Alchemist, probably pursued the making of gold as they looked for truth in nature, whilst modern biologists, like chemists, feel contented with isolated pebbles of a confused world.

As a tripod rests in part on each one of its three legs, Natural History achieved its support in part from each one of the three divisions mentioned above. As a result, naturalists were trained to appraise isolated facts only when correlated with others, and many of them, endowed with high powers of observation and piercing methods of reasoning, left through their writings an indelible mark for posterity, as exemplified by Aristotle, Plinius, Albert Magnus, Conrad Gessner, Francisco Hernández, Carolus Linnaeus, and Charles Darwin. Also, less rich in qualifications or more modest, other naturalists contributed to the progress of their science by either showing its value as an educational force, or by devoting their lives to the perennial search for additional specimens of the three kingdoms.

The study of minerals, plants, and animals requires no justification since it has been clearly established from the remotest antiquity that natural objects are interesting and valuable for man. However, the relations between Natural History and Reason, are less generally appreciated and may justify explanation.

Through Reason man rises to understand nature as an orderly array of phenomena, never beginning, never ending in their manifestations. Thought of in this way, a unified earth presents nothing superfluous, and nothing wanting. Not a single fact can be lost without marring the whole picture of nature, since all things are a continuous series of dependencies, each one conditional upon another. Every separate stone finds its final place in the wall of the building of Knowledge, in which facts represent the stones, and theory the cement. By studying natural things, man can attain a position so high that neither death nor time can change his station. We never think of Cuvier, Agassiz, or Humboldt as insignificant names recalling past glories, but as of intellectual giants of everlasting fame. These men found in the study of nature an adequate employment for their powerful minds, and in their works they built for themselves a perpetual monument. However, we must not forget that they were always convinced that nature was an orderly world of facts, embodying the constant unfolding of phenomena under the control of unified principles, expressed by them in laws still in common acceptance.

Naturalists explored the mineral kingdom in the search for independent objects, minerals, it is true, but only as a starting point for further developments. One result was the grouping of minerals in a series of

combined species, arranged in thirteen fundamental forms, each one with a definite plan, and each in some relationship to others. On every mineral they engraved some meaningful statements under the name of *characteristics*, thus constituting a sort of international language through which all members of the brotherhood communicated among themselves. One chapter of mineralogy was particularly important: crystallography, or the study of the crystalline form of minerals. In their crystalline state, minerals delighted old naturalists with the beauty of their characteristics, on some occasions to the point of making them powerless to express their properties in a single word. This search for words to describe such crystals became a search for truth, until Haüy the famous French mineralogist, by crushing a crystal, found in its broken fragments the primitive form of their complicated structure, which had been hitherto impossible to express in words. Minds then saw light, because truth was revealed by the clear understanding of the structure of the crystals. The study of their angles, their axes and their planes of cleavage was a subject of deep consideration, and mathematics combined with Natural History—numbers in things—filled volumes and volumes. Physics contributed also her “gadgets,” and when chemistry came into the picture, mineralogy allied to these sciences, formed the core of what are now called the physico-chemical and exact sciences. In this way Natural History achieved results wonderful in accuracy, and far-reaching in scope: the understanding of the geometrical nature of the form of crystals (and of all objects in the earth), the demonstration of the regularity in the sequence of species and of their transformation, announcing vaguely that changes in nature proceed in an orderly way. On the other hand, mineralogy gave to other studies a splendid foundation, by the exercise of the powers of observation through the appreciation of lustre, color, transparency, refraction, phosphorescence, density, hardness, taste, and odor of crystals.

Plants and animals offered new problems to the avid mind of naturalists, through the unfolding of new forces, and the presentation of new facts. Only one of these problems needs to be mentioned here to clarify this statement: the relation of parent and offspring, molding living matter into an uninterrupted—not so continuous, after all—series of individuals, linked by origin and organization, yet free moving and apparently self-determined. Life, the new entity, depended upon change to continue, whereas permanence characterized inanimated things. And what a variety!—fungi, lichens, mosses, grasses, flowering plants, sponges, polyps, worms, snails, insects, and vertebrates, in thousands of forms thrived in nature; yet all of them could be arranged by a systematic study of their characteristics into two kingdoms: the plant kingdom, which included all organisms more or less clearly recognized as such, and the animal kingdom, made up of the enormous number of living beings that were

capable of moving around upon the surface of the earth. However, it became soon known that no dividing line could be drawn between plants and animals, and transitional groups were established to fill the gap that separated botany and zoology. Not only living plants and animals attracted the attention of naturalists, but also forms long-since disappeared from land and water: fossils, once considered nature's freaks—*lusus naturae*. Such a great variety of organisms were animated with a vital spark, and ceaselessly reproduced themselves, until new forms advanced to the foreground to take their place when the older ones faded into a hazy past. Paleontology, the science of fossils, opened new fields of study, and in due time it became attached to geology and stratigraphy, as a guiding thread, to calculate the age of deposits and sediments. To understand living beings, past and present, the concentrated efforts of many generations of workers were required, although this may not be fully realized by those who see only the finished product: a name inscribed on a museum tag, a law formulated in a book, a collection of plants and animals maintained for purposes of exhibition or study.

Naturalists attempted to discover uniformity where nature showed diversity. Since nature never arranges things, naturalists sought to group them in categories of relations, and not of position. The place of individual plants and animals was to be found only after a complete study of their organization, functions, development and distribution; in other words, by a careful consideration of their natural affinities. In the beginning this information lay scattered and obscured under a mantle-rock of ridiculous minutiae or senseless interpretation, but in time the unfolding of the true nature of the characteristics of living beings gave place to a systematic knowledge, and taxonomy became a science. Taxonomy, it must be remembered, is the very point of beginning for any serious consideration of nature, since knowledge begins by giving a name to things.

Methods of study in Natural History required that minerals, plants and animals be treated as real things, and not as isolated morsels with mysterious properties. Work in Natural History demanded also a joint action of body and mind, by a balanced combination of physical and intellectual enterprises. The book of nature was the main volume to be consulted at all times, being always open and ready to yield information. Man-made books were only accessory sources of instruction, and investigation had to be original in the sense that it dealt with actual specimens, and not with abstractions or altered objects that are mere symbols of immaterial value. Faulty theorizing could be promptly corrected by reference to the real fact, whether it were the angles of a crystal, the roots of a plant, or the hairs of an animal. Thus, Natural History differed from speculation because the results of observation and reasoning were based upon the presence of the subjects of study. Laws expressed order and regularity, and were not rules full of exceptions. In addition to all that, minerals, plants

and animals were collected—they still are, fortunately—as objects of intrinsic value and extrinsic usefulness for coming generations, and not thrown away as exhausted samples, or merely tabulated in seldom-read reports.

In the course of centuries Natural History gave rise to many sciences, each one developing in due time its own methods, principles, and hypotheses, to become independent. This stolonian relationship, as Wheeler, the well-known American naturalist, explains, is demonstrated by the fact that every problem arising in taxonomy, morphology, paleontology, biochemistry, and in other sciences more or less closely related to them, generally has its origin in a study of Natural History. But, previous to the present multiplication of specialized fields of work, Natural History had contributed to the progress of knowledge with the following improvements, among many others: nomenclature and classifications, morphological principles of the structure of minerals, plants and animals, delicate techniques for collecting, handling and preserving of natural objects, wonderful collections and books of inspiring interest, and what is more important, rigid methods of reasoning and an integral vision of reality.

Since natural objects can not be ignored, the study of Natural History is inexhaustible. In land and water there are still unknown organisms, whose beauty and value invite naturalists to employ their powers to discover their characteristics, and to estimate their relationships. Yet not many people are attracted to Natural History due to a defective initiation, either because of incompetent teaching, or by mere limitation of their minds. In the second category are those who are contented to learn a name or how to stuff a skin. They miss the grain for the shell, because those who seek the truth must make a painful study of the order of nature, by calling to their aid all their powers of observation and of reasoning, so as to try to understand the nice distinctions drawn between facts. To the majority of human beings the study of nature, as the old naturalists practised it, brings a new sense of life, by training the intellectual capacities, and by promoting one of the most attractive fields for exercise, mental and physical.

COVER DESIGN, by Elsie Herbold Froeschner. Portrayed on the cover of this issue is one of the weevils or snout beetles (*Balaninus caryae* Horn), a member of the large family Curculionidae. The insects of this family are remarkable in having their jaws at the end of a beak. Among them are many species such as the cotton boll weevil, and the rice and granary weevils, which cause great economic damage. The genus *Balaninus* is notable for the length of the beak. This species was first reared by entomologists from hickory nuts (*Carya*) and for this reason was named *B. caryae*. It attacks pecans as well as hickory nuts and is generally known as the pecan weevil. It is found from New York to the Gulf States and westward into Iowa. The female requires about seventy-five minutes to drill a hole with her beak through the shell of a hickory nut, after which she deposits an egg in the hole by means of an ovipositor of the same shape as the beak.

Leaf Form and Variation: Bignoniaceae

SISTER MARY ELLEN O'HANLON¹

Anyone who adopts the hobby of sprouting seeds of various kinds will doubtless meet with some surprises and may be puzzled at times by various unexpected forms and characters among the different seedlings. Every seedling includes three types of leaves, in most species more or less easily distinguished according to their origin, the order of their development, and their function. These three types of leaves are very distinct in most seedlings of the Leguminosae, examples of which are the common bush bean or lima bean and the soya bean. Although these two plants represent different genera, their seedlings are very similar. In both, the cotyledons rise above the surface of the soil and become somewhat green, although they soon wither and drop off. In each of the seedlings of these two plants, there is a pair of simple leaves, readily recognized as the primary leaves, which are borne opposite each other, the secondary leaves of both plants are alternately arranged on their stems and are pinnately compound leaves of three leaflets each. Up to this point in the development of the seedlings of both the lima bean (*Phaseolus* sp.) and the soya bean (*Glycine soja*) the two might be easily confused, particularly were one to neglect the differences in the seed size and shape. The differences in the characters of the adult plants are very pronounced.

In a large number and variety of plants the close resemblances between the young of different genera, or those of much less closely related species, suggest the application of the Recapitulation Theory which formerly was taken so seriously in the zoological field as to be called the "Biogenetic Law," a principle which states that the individual plant or animal, in its complete development from the egg through its life span, passes through a series of stages which are considered structurally similar to the stages through which the race has passed in its supposed evolutionary history. This incident in biological history tends to make the botanist a little more cautious and circumspect in his conclusions and statements relative to the same principle, which is at least as applicable to plants as it is to animals.

The brief paper includes some results which might readily lend themselves to erroneous conclusions. Previous experiments and observations² on other plant groups, however, furnish data which discourage any definite conclusions or generalizations here.

¹ Chairman, Department of Biology, Rosary College, River Forest, Illinois.

²O'Hanlon, M. E. Leaf Form and Variation, The Sci. Counselor, 9:18, 1943.

In observing various members of the bignonia family one is immediately struck with the variety of foliage types which characterize the adult plants. The majority of the approximately five hundred species of this family are woody perennials, including trees, shrubs, and vines.

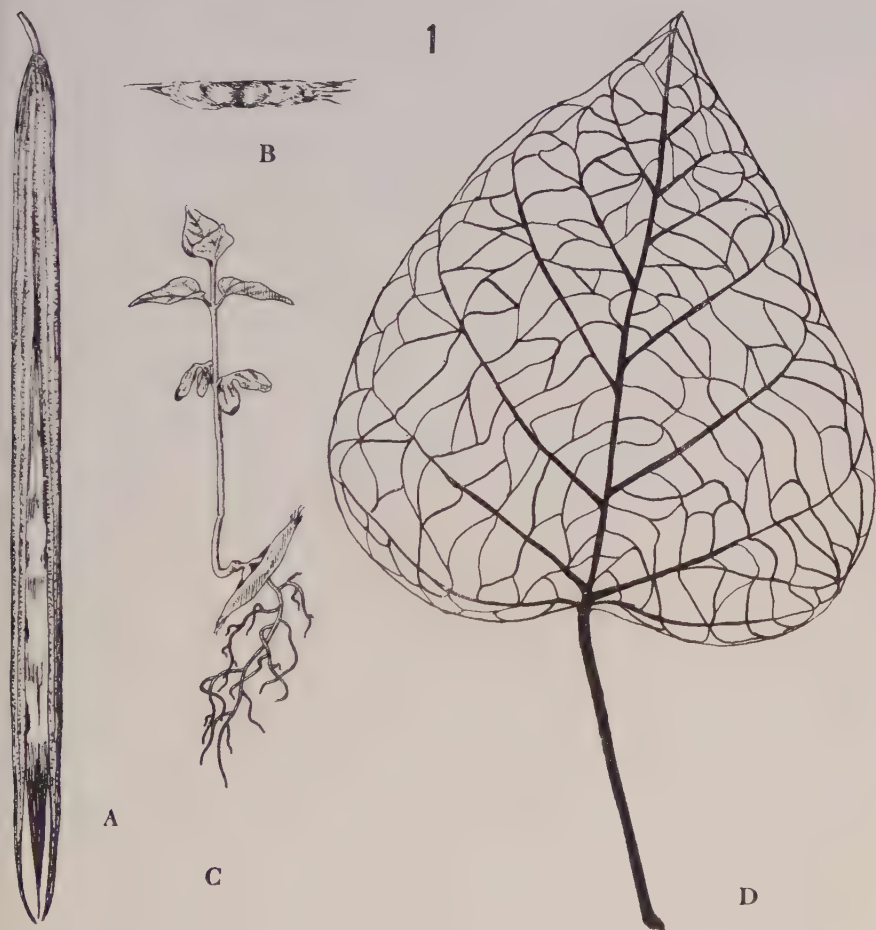


Figure 1. *Catalpa catalpa*. A—fruit pod; B—seed; C—seedling; D—adult leaf.

Most of the species are tropical and are native to South America, but a few are native to the temperate regions and some are found in North America. The general character of the flowers and fruits of the various members of this family suggests their close relationships even to the amateur.

Catalpa (*Catalpa catalpa*)

The catalpa, one of the three species of the genus, is well-known throughout the United States and is easily recognized by anyone who has even a passive interest in trees. Because of its large simple leaves, often called elephant's ears, its dense showy flower clusters, and the bean-like fruits which hang on the branches long after the trees are otherwise bare, the catalpa is quickly identified at all times.

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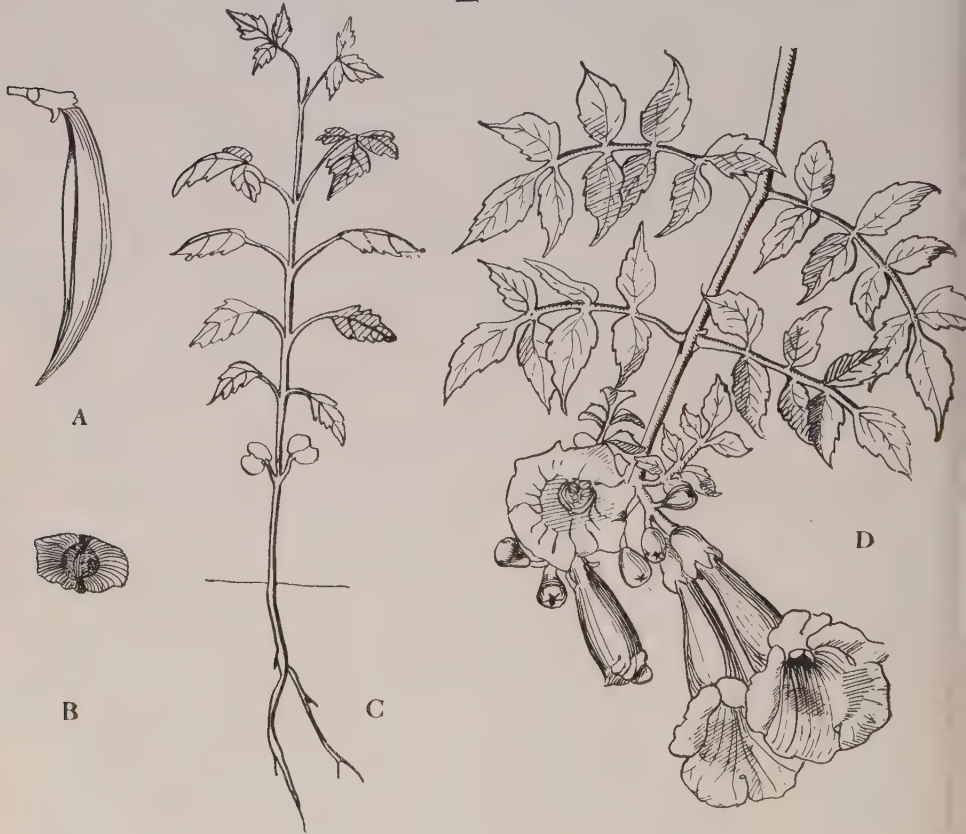


Figure 2. *Bignonia radicans*. A—fruit; B—seed; C—seedling; D—branch bearing leaves and flowers.

The cotyledons are deeply bilobed and are folded so that their outline is easy to trace on the outer side of the seed (Fig. 1, B). The base and apex define the short axis of this wide, flat seed, each side of which bears a tuft of hairs. The young plant emerges from the apex of the seed in the manner which is characteristic of the dicotyledons.

The primary leaves are of the same general form and character as the secondary leaves and these, although much smaller, do not differ in their essential structure from the adult leaves (Fig. 1). It is therefore possible to distinguish the primary and secondary leaves only by the order in which they appear and by their position on the stem.

Trumpet Creeper (*Bignonia radicans*)

This vine, commonly called the trumpet vine or the trumpet creeper, is well-known throughout the United States, although the species of *Bignonia*, all tendril climbers, are mostly tropical. The trumpet vine is particularly attractive for its profusion of deep green foliage and its clusters of large trumpet-like, orange-red flowers. The pod is similar to that of the catalpa, but it is shorter and thicker and therefore more like a bean pod. The seeds, like all others of this family, are equipped for wind dispersal, but instead of the tufts of hairs, the sides of the seed of *Bignonia radicans* are extended by a pair of membranous wings (Fig. 2, B). The seeds of the trumpet vine sprout quite readily and release a pair of cotyledons which are also bilobed but much less deeply cut than those of the catalpa. The primary leaves and several pairs of the secondary leaves are all of the simple type, and it is doubtful whether any of the leaves of the first year plant ever attain the full number of leaflets which characterize the adult plant (Fig. 2, C.) *Bignonia radicans*, in marked contrast to the young catalpa, has easily distinguished cotyledons, primary leaves, early secondary leaves, and adult leaves. The secondary leaves, depending upon the age of the plant, are simple leaves, compound leaves of three leaflets each, and leaves of seven or nine leaflets each.

Jacaranda (*Jacaranda acutifolia*)

The jacaranda is a South American tree, the name of which is of Brazilian origin. There are probably fifty species of this genus, including both trees and shrubs, all native to tropical America. The illustrations (Fig. 3) were made from specimens collected in the environs of Los Angeles where this tree is widely grown for its beauty. The rich foliage remains on the tree all winter and the immense clusters of violet blue flowers continue to bloom during a great part of the summer. The fruit is a pod which in its essential structure, as well as in the character of the seeds it bears, is similar to the catalpa and bignonia fruits, but it differs from them in shape and texture. This pod resembles a turtle shell in shape and is also very thick and hard. No doubt this is the reason one of the species is called *Jacaranda chelonia*.

The seed of *Jacaranda acutifolia* sprouts promptly and the young plant bears bilobed cotyledons very similar to those of *Bignonia radicans*. All of the leaves of the seedling are but once pinnate and the first pair, the primary leaves, each bears a much reduced number of leaflets. This number increases in subsequent leaves of the seedling, but there are probably never

any twice compound leaves in the first year. Hence, as in *Bignonia radicans*, several types of leaves are very distinct in this plant: cotyledons, primary leaves, secondary leaves (the latter with an increasing number of parts according to the age and development of the seedling) and, finally, the adult leaves which are beautifully fernlike, made up of ten or more pairs of compound leaflets each.

3

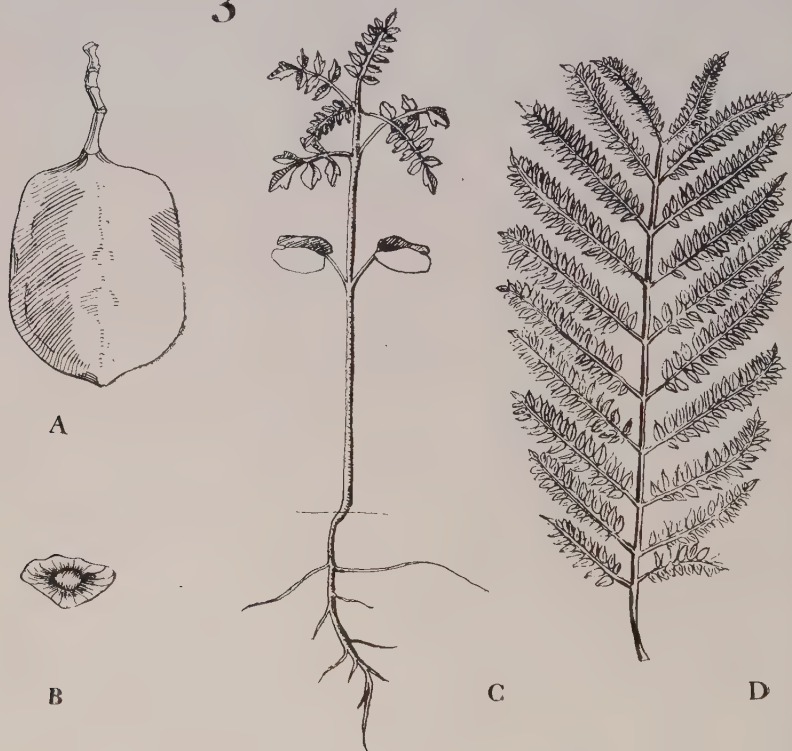


Figure 3. *Jacaranda acutifolia*. A—fruit; B—seed; C—seedling; D—adult leaf.

Desert "Willow" (*Chilopsis linearis*)

The desert willow or flowering willow is a deciduous tree or shrub which is native to Texas, New Mexico, Arizona, and California. The flowers (lilac-pink or white) resemble those of the catalpa in most of the essential characters. This is also true of the fruit (Fig. 4). The leaves, however, often not opposite, are willow-like in form. Since we have had no opportunity to collect seeds of this plant or to obtain them otherwise, we can only guess at the possible structure of the cotyledons and other seedling characters. Therefore, no general conclusion as to leaf form based on the life histories of these types is warranted, even for this single family.

Were we to judge from *Bignonia* and *Jacaranda* only, the conclusion might be that progress is toward the more complex leaf since the more simple leaf forms are found in the seedlings and the more complex leaves

4



Figure 4. *Chilopsis linearis*. Branch bearing leaves, flowers, and a fruit pod.

in the adult plants. The question arises, however, as to what may be considered progress, in the evolutionary sense, as regards leaf form and structure; that is, whether a plant bearing simple leaves is *less* or *more* highly evolved than one which bears fewer leaves, each one of which is much larger and more complicated in structure.

Many of the primitive seed plants, the cycads and their fossil ancestors, for example, have very large and complicated leaves, the total number of which is relatively small. In this respect they resemble their fern ancestors and most of the present ferns. On the basis of their evolutionary sequence, that is to say, from the standpoint of the development of the race, it seems

the compound leaves might be considered the more primitive and that evolutionary progress is toward simple but very numerous small leaves. Nevertheless, the life histories of some of the plants, such as these genera of the bignonia family and many others of the more recent seed plants, seem to antagonize this theory. In two of the species here discussed, *Bignonia radicans* and *Jacaranda acutifolia*, as has been seen in their life histories, the development is from the simple to the complex leaf. The catalpa type may be considered neutral so far as this theory is concerned. It might be predicted, however, that *Chilopsis linearis*, the desert willow, grew from a seedling which bore more complex leaves than those of the adult. Such a condition exists, for example, in the desert tree *Acacia pycnantha*³ in which the primary and a few of the secondary leaves are pinnately compound, whereas subsequent leaves and all of the foliage of the adult tree are reduced to simple phyllodia—structures not really more than petioles—in this xerophyte.

To say that certain types of leaf structure, the reduction of their foliage, or the complete absence of leaves, as in some desert plants, are due to adaptations of these specific plants to environmental conditions or changes is only an attempt to dispose of the question without answering it. It is plain from observation and experiment that only certain plants manifest such ability to "adapt" themselves to xerophytic conditions or to other environments which are unfavorable to luxuriant plant growth and development. These particular species, unlike the majority of plants, are evidently inherently equipped to become adapted to such unusual conditions. Indeed they seem to be hereditarily endowed with the faculties which are directly conformable to the particular environment to which they are sometimes said to "adapt" themselves. Those who lay claim to any serious understanding of natural phenomena must be convinced that the so-called adaptations are nothing more nor less than an element in the nature of the exceptional plant which can thrive where hundreds of others would perish. Some types of plants, too, flourish in a much wider climatic range than is possible for others. Thus it seems plain that all such variations in plant structure are due fundamentally to different degrees of inherent ability to cooperate with or to resist the environmental conditions which to most plants are insuperable impediments. Whatever is inherent in an organism which enables it to "adapt" itself and to be influenced in its development by any particular set of environmental conditions, it is quite evident that leaf form and variation in the different species seem to be a response primarily to hereditary factors.

³The diversity of leaf form throughout the Leguminosae is so pronounced that it merits special study. A later paper will illustrate some of the features of the seedlings and the adult leaves of various genera of this large alliance.

Museum Activities

Fall Sunday Lectures

The fall series of Sunday Afternoon Lectures starts November 4 and continues through December 16. These programs, as usual, are free to the public.

Because of the greatly increased attendance, two showings are scheduled for each program—at three o'clock, our traditional hour, and repeated at 4:15 P. M.

Members of the Academy may reserve places either by writing the Academy or telephoning LINcoln 0606 up to noon on the Saturday preceding each lecture. Please specify whether reservations are for the first or second program. Reserved seats for members are held until the lecture starts. *Associate* members are asked to limit reservations to two per program, active members to four. Doors of the auditorium are opened at 2:15.

Nov. 4: **The Yosemite Valley** (illustrated with 4 x 5 inch Kodachrome slides), C. O. Schneider, M. D., Winnetka.

Nov. 11: **Getting Close to Heaven in "Cool Colorado"** (natural color motion picture and lecture), Sam Campbell, "The Philosopher of the Forest", courtesy of the Chicago and North Western Railway.

Nov. 18: **Desert Miscellanea** (natural color motion pictures of wildlife in southern Arizona), Howard K. Gloyd, Ph. D., Director of the Academy's Museum.

Nov. 26: **Alluring Alaska** (natural color motion picture), Frank Dufresne, Division of Information, U. S. Fish and Wildlife Service.

Dec. 2: **Holiday on Horseback**—Jasper National Park and Mt. Robson (2-inch Kodachrome slides), Charles E. Bacon, Chicago.

Dec. 9: **Out Where the West Begins**—Bad Lands, Black Hills, Devil's Tower, and Rocky Mountain National Park (natural color motion picture with recorded music), Arthur H. Elliott, Oak Park.

Dec. 16: **Amazing America**—California and adjacent areas, Christmas at Scotty's Castle in Death Valley (natural color motion picture with recorded music), Ray Eggersted, Elgin.

Weeds and Insects Studied by School Classes

The correlation of a special study exhibit of weeds and a showing of the Academy's 30-minute natural color movie on insects proved so popular with schools last fall that these services were again offered to classes visiting the museum during October. Response to an invitation mailed to all high schools, and published in the Chicago Board of Education's *Superintendent's Bulletin* has been gratifying.

Over 290 common local weeds, grouped according to plant families, are displayed in the auditorium in bulletin-board alcoves surrounding work tables for the convenience of study groups. The specimens are from the herbarium of Anna Pedersen Kummer, honorary curatory of botany of the Academy and a teacher of botany at Waller High School. The Academy is deeply indebted to Mrs. Kummer for again lending her collection and setting up the exhibit.

Since this study of weeds and of insects are both fall curriculum units in biology, most instructors are scheduling a half-day's field work at the Academy. This fall's lobby display, *The Garden Family Album*, is tied in with the plant families represented in the temporary weed exhibit; and examination of the systematic series of insects (a permanent museum exhibit) is followed by a lecture illustrated with the Academy's outstanding nature film on insect life, made during a series of expeditions in Arizona.

The Naturalist's Book Shelf

HOW TO KNOW THE MOSSES

By Henry S. Conard

Wm. C. Brown Company, Dubuque, Iowa, 1944, 166 pages, 362 figures, index and glossary. Spiral binding \$1.50, cloth \$2.50.

Many people express an interest in mosses as they notice them in their rambles in fields and woods, yet comparatively few carry out this interest enough to inform themselves about their habits of growth, or learn to identify them and call them by name, as they readily do flowering plants. Perhaps this is partially because few books about mosses have been made for the use of the student who has a limited knowledge of the necessary scientific terms and feels timid about acquiring a new set of such terms.

Dr. Conard has prepared in his book a guide for such persons that seems to meet exactly this need. In his introduction the author says, "This little book of ours is an attempt to simplify the identification of mosses. We have culled out the most distinctive recognition characters, and these are shown in pictures adjacent to the verbal descriptions."

The inclusion of the liverworts makes the book even more valuable and while the author has the needs of the ordinary student chiefly in mind, he arranges the matter in a true scientific way.

To me who studied mosses "the hard way," this little book makes me regret it was not available long ago, and I am especially pleased that copies have gone into libraries of two institutions nearby, where teachers and students may use them freely.

It is gratifying to note the return of the mosses during our rainy seasons which have followed the dry years, when these plants were scarcely to be found. With Dr. Conard's book in hand and mosses growing and fruiting everywhere, there should be no lack of "good hunting" for the nature lover.

Grace R. Meeker

AMPHIBIANS AND REPTILES OF THE CHICAGO AREA

By Clifford H. Pope

Chicago Natural History Museum, Roosevelt Road and Field Drive, Chicago 5. 1944, 275 pages, 12 plates (6 colored), 50 text figures, index; paper cover. \$1.75.

A new regional handbook by one of our best known herpetologists has been published by the Chicago Natural History Museum. In accordance with the museum's recent policy of popularizing the appearance of its less technical works, the bright-colored cover is emblazoned front and back with fore and aft views of a smiling spotted salamander drawn in the tradition of many illustrations for children's books. When I congratulated Clifford Pope on the publication of this excellent local monograph, he asked how I liked the cover. "Well," I said, "the design seems rather infantile to me."

"That's what it's meant to be: a juvenile salamander."

When I suggested that perhaps it might be misleading to the purchasing public, he replied, "So you want it to look more dignified. We'll put spectacles on the salamander next time!"

Written primarily for the amateur naturalist, even for the novice in herpetology, with technical terminology practically eliminated, this book is in no sense a "juvenile." It treats the 52 kinds of amphibians and reptiles found within a 70-mile radius of Chicago with more thoroughness than any similar regional study hitherto produced. Each main division (Salamanders, Frogs, Lizards, Snakes, and Turtles) is headed with a section on methods of identification, including simple keys. The species are discussed under a series of subheadings with special emphasis given to such items of natural history as differentiation of the sexes, breeding habits, growth and age, food, economic importance, captivity, and local occur-

rence. As stated in the introduction, "the aim is to arouse interest in reptiles and amphibians by showing that each kind has its own habits, worthy of special and detailed attention," and "... numerous details are included because much of the fascination of animal behavior lies in its complexity."

The illustrations are excellent although some of the color plates are inconveniently placed; e.g., Plate 5, showing color changes of the tree frog appears in the section devoted to the identification of snakes.

The book is of attractive format and excellently made throughout. One feature, however, is particularly annoying to this reviewer: the page numbers are placed at the *inner* margins of the pages. After grinding my teeth in helpless rage while trying to find the remainders of continued articles in some of the current magazines (and even daily newspapers) with page numbers displaced by illustrations "bled off" at the margins, or coyly hiding behind advertisements or clever layouts of other kinds, I had a distinct feeling of "there ain't no justice" when this insidious form of frustration appeared in a book about my friends "the herps." Somehow I had acquired the idea that tables of contents, indices, and page numbers were to make a publication *convenient* to use. Mr. Pope explained, however, that in his book the "running heads" of the pages, with the common names of the animals on the *outer* margins, were supposed to make the accounts of the individual species easy to find, and to reduce the need for using the index, which, incidentally, is prepared with proficiency and thoroughness.

In this publication a new style has been set. Mr. Pope's literary skill and complete knowledge of his subject have produced a charmingly readable, authoritative, and stimulating account of these relatively little-known vertebrates.

H. K. Gloyd.

REPTILES AND AMPHIBIANS OF MINNESOTA

By W. J. Breckenridge

University of Minnesota Press, Minneapolis, 1944,
xii, 202 pages, 52 figures, 45 maps, glossary, bibliography, index. \$2.50.

The study of amphibians and reptiles has received less attention in the north-central United States than in many other parts of the country and the increasing number of students interested in these vertebrates will welcome Dr. Breckenridge's book. It results from a large amount of field work, a review of the published literature, and a study of museum specimens, including much new material collected by the author and his associates.

The introduction deals briefly with the history of herpetology in Minnesota, tales about reptiles and amphibians, the distribution of these animals in the state, field methods, care of reptiles and amphibians in captivity (by Milton Thompson), the bites of venomous snakes and their treatment, the preservation of specimens, and classification, including keys for the identification of amphibians and reptiles in Minnesota. The keys include species from adjacent areas thought likely to be found eventually within the limits of the state. Records of certain species known, or thought, to have been erroneously reported from the state and those to be expected but not yet actually recorded are discussed in a hypothetical list.

The body of the work treats the 45 species (5 salamanders, 13 frogs and toads, 3 lizards, 16 snakes, and 8 turtles) known from Minnesota in systematic order, using the common names and the Latin binomials in the headings, even though only one subspecies occurs in the state. For the species in which subspecies are known and named the number of subspecies recognized is given in a separate paragraph and those found in Minnesota are indicated by their scientific trinomials. A map for each species shows individual known records for the state and a smaller map

of North America is inserted to indicate the general range, although on a scale too small to be thoroughly satisfactory. In the text the species are described with the minimum use of technical terms, the geographic ranges are stated (often quoted from the fifth edition of the Stejneger and Barbour check list), and under habits brief general accounts of the natural history of the species are in many cases supplemented by original data from the observations of the author.

The 52 figures in the text are reproductions from photographs and drawings by the author. There is an adequate glossary, a bibliography of 163 titles, and an index.

This book will be useful to anyone interested in herpetology: to the beginner, especially if he resides in the region covered, and to the more advanced worker because of the original observations recorded.

H. K. Gloyd.

EENY, MEENY, MINEY, MO—and STILL-MO

By Sam Campbell

Bobbs-Merrill Company, Indianapolis, 1945, 537 pages, numerous sketches by Will Forrest.

Cloth, \$2.00.

Sam Campbell's third book tells the story of orphaned red squirrel quintuplets—the "squints," whose antics as infants made so hilarious the pre-embarkation leave spent by Duke, a young army captain, at the Campbells' northwoods sanctuary.

The narrative, which not only introduces many new amusing animal personalities but brings up to date for Sam Campbell fans the stories of earlier friends, provides charming entertainment. The underlying theme of the book—"the everlasting goodness of Nature and Nature's God"—furnishes reassurance badly needed in this period of individual and national readjustment.

Harriet M. Smith.

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